Renewable and Sustainable Energy Reviews 18 (2013) 499–507

Contents lists available at SciVerse ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

Energy conservation in China's Twelfth Five-Year Plan period: Continuation or paradigm shift?

Kevin Lo*, Mark Y. Wang

University of Melbourne, Department of Resource Management and Geography, Melbourne, VIC 3010, Australia

ARTICLE INFO

Article history:
Received 14 April 2012
Received in revised form
23 October 2012
Accepted 27 October 2012
Available online 23 November 2012

Keywords:
Energy conservation
Energy and climate policy
Policy analysis
12th FYP
China

ABSTRACT

The release of the *Twelfth Five-Year Guideline for National Economic and Social Development* in March 2011 marked the beginning of China's Twelfth Five-Year Plan (12th FYP) period (2011–2015). Energy conservation continues to be a national priority. Since the release, new energy conservation policies and programs have been announced by many central ministries in accordance with the 12th FYP. Is this the beginning of a new paradigm or merely a continuation of the 11th FYP model? This paper describes and analyzes key changes in energy conservation since 2011, including a more conservative national energy conservation target, a more logical way of breaking down the target, new sectoral targets, the introduction of new programs, and the expansion of existing programs. However, one key problem of the 11th FYP period remains unresolved, namely the inability to shift the economy away from heavy industry.

Contents

1. Introduction

On March 14, 2011, the *Twelfth Five-Year Guideline for National Economic and Social Development* was approved at the annual meeting of the National People's Congress, marking the beginning of the Twelfth Five-Year Plan (12th FYP) period (2011–2015). Energy conservation continues to be a national priority due to energy security, climate change and pollution considerations [1,2]. In the months following the release, a number of government documents detailing new energy conservation targets and programs were drafted by various ministries in accordance with the 12th FYP. These include the *12th FYP Energy Conservation and Emission Reduction Work Plan* [3] and the *12th FYP for Energy Conservation and Emission Reduction* [4] by the State Council, the *Implementation Plan for Ten Thousand Enterprises Energy Conservation* [5] by the National Development and Reform Commission

* Corresponding author. Tel.: +61 43 85 5320; fax: +61 392 506 885.
E-mail address: tslo@unimelb.edu.au (K. Lo).

1364-0321/$ - see front matter
http://dx.doi.org/10.1016/j.rser.2012.10.042

Table 1
Results of major energy conservation policies in the 11th Five-Year Plan period.

Policies and effective date	Target (Mtce)	Result (Mtce)	Contribution to overall target (%)
Thousand Enterprise Program (April 2006)	100	165	26.2
Ten Key Projects (July 2006)	240	340	54.0
Obsolete Capacity Retirement Program (December 2005)	118	118	18.7
Total	458	623	98.9

Note: Because of a lack of data, the result of the Obsolete Capacity Retirement Program was estimated based on the official announcement that the target was achieved.
Source: [18,20–24].

Table 2
Results of the Thousand Enterprise Program by industry.

Industry	No. of enterprises	No. of enterprises that failed to meet target	Target (Mtce)	Result (Mtce)	% of target achieved
Chemicals	213	7	12.2323	22.2825	182
Coal mining	61	2	6.959	13.9121	200
Construction materials	86	2	4.736	8.0136	169
Electricity	122	0	9.5471	21.1841	222
Iron and steel	211	4	36.4197	60.7903	167
Non-ferrous metals	65	0	4.8958	9.1415	187
Petroleum and petrochemicals	81	0	13.5111	25.5458	189
Pulp and paper	24	0	1.3325	2.8941	217
Textiles	18	0	1.0158	1.7284	170
Total	881	15	90.6493	16.54924	183

Note: Source: [24].

(NDRC), the *12th FYP for Industry Energy Conservation* [6] by the Ministry of Industry and Information Technology (MIIT), the *12th FYP for Building Energy Conservation* [7] by the Ministry of Housing and Urban–Rural Development (MOHURD), the *12th FYP for Transport Energy Conservation* [8] by the Ministry of Transport and the *12th FYP for Government Agency Energy Conservation* [9] by the Government Agency Office.

Is this the beginning of a new paradigm or merely a continuation of the 11th FYP model? To answer this question, we conducted a systematic review of the new targets and programs, as well as the ways in which existing programs have been modified. Because several overviews of 11th FYP energy conservation policy have been published [10–13], we focused on government documents released since 2011. We further limited our search to the national level, where the majority of energy conservation policies are formulated. However, we acknowledge that provincial and municipal programs also play a role in energy conservation [14–17].

This paper begins with a brief discussion and evaluation of energy conservation policy in the 11th FYP period. We highlight the paradoxical coexistence of individual successes among the key energy conservation programs and their collective failure to meet the national energy conservation target. This is followed by an analysis of energy conservation policies and programs in the 12th FYP period, with a focus on changes and new measures. This paper concludes with a reflection on the promises and limitations of energy conservation in the 12th FYP period.

2. 11th FYP energy conservation: Successes and failures

The national energy conservation target in the 11th FYP period was to reduce energy intensity by 20% [18]. Overall, energy intensity decreased by 19.06% from 2006 to 2010, which was equal to 630 million tons of coal equivalent (Mtce) of energy savings [19]. Most of the savings can be attributed to three policies: the Ten Key Energy Conservation Projects (“Ten Key Projects”), the Thousand Enterprise Energy Conservation Program (“Thousand Enterprise Program”) and the Obsolete Capacity Retirement Program (Table 1).

2.1. Ten key projects

The Ten Key Projects consisted of an array of programs that covered industry, transport, building and public sectors with a focus on the energy-intensive industry sector [21]. The key component was a subsidy program to help enterprises adopt energy efficient technologies. In total, the government invested 30 billion RMB (1 RMB = 0.1595 USD as of October 2012) in approximately 5200 projects, with the majority in schemes such as retrofitting coal-fired industrial boilers, replacing small and inefficient power plants with cogeneration plants, utilizing waste heat and pressure, optimizing energy-intensive industries’ energy systems and installing energy-efficient motors [21]. Additionally, the Ten Key Projects introduced the building energy efficiency standards and retrofitted existing residential buildings, street lighting and public buildings. Overall, the Ten Key Projects saved 340 Mtce of energy, which was 142% of the original target [23].

2.2. Thousand enterprise program

The Thousand Enterprise Program was based on the experience of a pilot voluntary agreement for an energy efficiency program in Shandong Province [25]. The program was, however, made mandatory as enterprises were given energy conservation targets that they would be punished for not meeting [11]. The program targeted the 1008 largest enterprises in nine energy-intensive industries. Collectively, the enterprises accounted for 33% of China’s total energy use in 2005 [20]. Because of merging, bankruptcy and other reasons, only 881 enterprises remained in the program at the end of 2010. Table 2 summarizes the results by industry. Of the 881 firms in the program at the end of 2010, 866

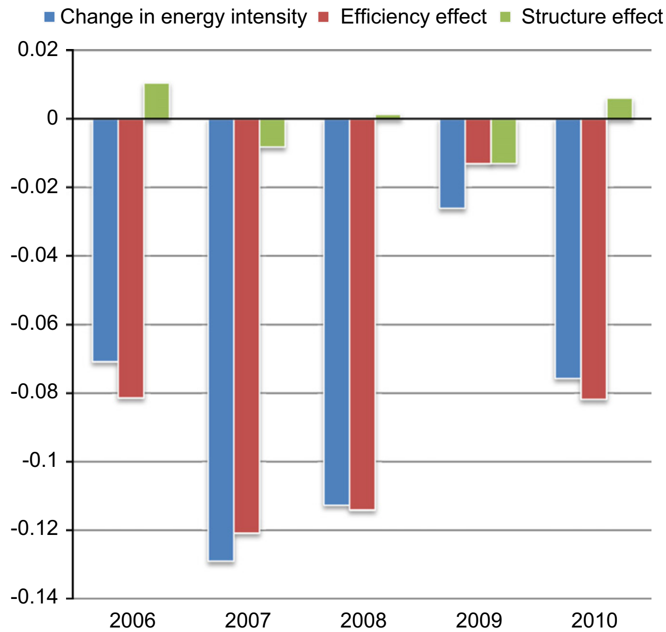


Fig. 1. Change in energy intensity during the 11th FYP period.
Note: Sourced from [36,37] and calculated by the authors.

firms (98.3%) met their targets. The electricity sector was the best performer, despite the many impediments the industry faced [26]. The 122 electricity enterprises together saved 21.1841 Mtce of energy, which was 2.22 times greater than the target savings of 9.5471 Mtce. The program conserved 165 Mtce of energy which was 183% of the original target.

2.3. *Obsolete capacity retirement program*

The Obsolete Capacity Retirement Program sought to improve energy efficiency by phasing out outdated production capacity in 14 energy-intensive industries [11].[1] As with the Thousand Enterprise Program, the enterprises were responsible for implementation, while the role of the government was that of monitoring and support. Funding was provided to support affected enterprises. In total, 72,000 MW of coal-fired power generators, 122 million tons of iron production capacity, 70 million tons of steel production capacity and 330 million tons of cement production capacity were retired during the 11th FYP period [27].

2.4. *Structure effect, rebound effect and overall energy conservation*

As noted by Yuan et al. [12], achieving the national energy intensity target was anything but smooth and orderly, especially in the final year of the 11th FYP period. The first half of 2010 saw an increase in energy intensity. Energy intensity fell again from late July 2010 to the end of the year, but not always in the way the central government wanted. Many local governments restricted electricity supply to industries, residential buildings and public facilities [28,29]. Even with these extreme measures, the 19.06% reduction in energy intensity over five years was almost a full percentage lower than the original target.

Given that all three major policies fulfilled or even exceeded their goals, one may wonder why the country as a whole had so much trouble attaining the 20% energy intensity reduction target. The coexistence of individual successes achieved by the key policies and their collective failure to deliver the national energy conservation target is paradoxical. It should be noted that double counting existed between the Thousand Enterprise Program and the Ten Key Projects because enterprises listed in the Thousand Enterprise Program could apply for funding through the Ten Key Projects, and the result would be attributed to both programs [30]. However, the overlap was quite small and therefore did not fully solve the puzzle.[2] In the remaining part of this section, we discuss two barriers to energy conservation in the 11th FYP period: the structure effect and the rebound effect.

Economy-wide energy intensity is affected by both the efficiency effect, defined as the change in energy efficiency, and the structure effect, defined as the structural change of the economy. By way of example, improving energy efficiency through technological or behavioral transformation is an efficiency effect, whereas a decline in the relative weight of energy-intensive sectors is a structure effect. It is obvious that all three policies discussed previously focused on the efficiency effect. No credible policy was drafted to control the growth of energy-intensive industries. Consequently, during the 11th FYP period, industrial energy consumption increased from 1595 to 2400 Mtce. The industry sector consumed approximately 73% of China's total energy by the end of 2010, an increase from 70.9% in 2005 [6]. The six most energy-intensive industries used 77% of total industrial energy, an increase from 71.3% in 2005 [6]. In other words, the inability to diversify the economy away from energy-intensive industries was a key problem for energy conservation in the 11th FYP period. Fig. 1 shows the change in energy intensity, broken down into efficiency and structure effects. While the efficiency effect always contributed to a decrease in energy intensity, the structure effect contributed to a small increase in energy intensity in 2006, 2008 and 2010. This is different from China's experience from 1980 to 2002, where the structure effect contributed to a decline in energy intensity [31–33]. The situation is however similar to that of the 10th FYP period (2001–2005), when the rapid growth of energy-intensive industries resulted in an equally rapid increase in energy intensity [34].

Related to the structure effect is the rebound effect, defined as additional energy use triggered by greater energy efficiency. Enterprises that improve their energy efficiency may as a result use energy-consuming equipment more intensively or invest the financial savings in more energy-intensive equipment [35]. It is likely that the industrial energy efficiency programs in the 11th FYP period further stimulated the growth of heavy industries, thus inadvertently contributing to the structure effect. More empirical research is needed to quantify the magnitude of the rebound effect.

3. 12th FYP energy conservation: Key changes and new measures

This section discusses changes in energy conservation since 2011. Table 3 lists active energy conservation policies and programs in the 12th FYP period, organized by sector.

3.1. *Framework policy*

The Energy Conservation Target Responsibility System imposes mandatory energy intensity reduction requirements on local

[1] The 14 industries were: electricity, iron, steel, aluminum, ferroalloy, calcium carbide, coke, cement, coal mining, glass, pulp and paper, alcohol, monosodium glutamate (MSG) and citric acid.

[2] Levine et al. [24] estimate that the magnitude of the double counting was approximately 5%.

Table 3
Key energy conservation policies in the 12th FYP period.

Sector	Policy	Policy instrument	Policy documents
Framework policy	12th FYP Energy Conservation Target Responsibility System	Regulation	[3,38]
Industry	Ten Thousand Enterprise Energy Conservation Program	Regulation	[5,39]
	Obsolete Capacity Retirement Program	Regulation	[40–42]
	Energy Conservation Technology Fund	Incentive	[43]
	Differential Electricity Pricing	Economic instrument	[44]
	Small Business Closure Program	Regulation	[45]
	Promotion of Energy Conservation Products Program	Incentive	[46]
	National Energy Conservation Campaign	Education	[47]
	Development of the Energy Services Industry	Incentive	[48,49]
	Key Energy Conservation Technologies Catalogue	Education	[50]
Building	Building Energy Efficiency Standards	Regulation	[7]
	Retrofitting Existing Residential Buildings	Investment	[7]
	Retrofitting Public Buildings	Investment	[7]
	Integrated Renewable Energy	Incentive	[7]
	Promotion of Green Buildings	Incentive	[7]
	Energy-Efficient Product Discount Scheme	Incentive	[51]
	Incandescent Lighting Phasing Out Program	Regulation	[52]
	Differential Electricity Pricing	Economic instrument	[53]
	Ten Thousand Enterprise Energy Conservation Program	Regulation	[5,39]
	Development of the Energy Services Industry	Incentive	[48,49]
	National Energy Conservation Campaign	Education	[47]
Transport	Commercial Vehicle Fuel Standards	Regulation	[54–56]
	Road Passenger Transport Capacity Control	Regulation	[57]
	Thousand Enterprise Low-Carbon Program (transport)	Voluntary agreement	[8]
	Transport Energy Conservation Fund	Incentive	[58]
	Transport Energy Conservation Demonstration Projects	Investment	[59]
	Low-Carbon Transport System Development Program (pilot)	Incentive	[60]
	Ten Thousand Enterprise Energy Conservation Program	Regulation	[5,39]
	Energy-Efficient Product Discount Scheme	Incentive	[51]
Public	Public Sector Key Energy Conservation Projects	Investment	[9]
	City Green Lighting Project	Investment	[61]
	Compulsory Government Procurement of Energy-Saving Products	Procurement	[62]
	National Energy Conservation Campaign	Education	[47]

Table 4
12th FYP provincial energy conservation targets.

Target (%)	Provinces
18	Guangdong, Jiangsu, Shanghai, Tianjin, Zhejiang
17	Beijing, Hebei, Liaoning, Shandong,
16	Anhui, Chongqing, Fujian, Heilongjiang, Henan, Hubei, Hunan, Jiangxi, Jilin, Shanxi, Shaanxi, Sichuan
15	Gansu, Guangxi, Guizhou, Inner Mongolia, Ningxia, Yunnan
10	Hainan, Tibet, Xinjiang

Source: [3].

governments. The function of any target responsibility system is to ensure that central policies are carried out by local officials. This is achieved by linking the implementation of central policies to financial bonuses and career advancement of local cadres [63–65]. First created in 2007 [38], the Energy Conservation Target Responsibility System proved to be an effective enforcement mechanism when local government scrambled to deliver the targets with whatever means available to them in 2010.

Four notable changes were made to the Energy Conservation Target Responsibility System in 2011. The first change is the adoption of a national target of 16%, which is 4% below that of the 11th FYP. The 11th FYP's 20% reduction in the energy intensity target was considered by many to be too ambitious, considering that energy intensity increased by 9.8% in the three years preceding the 11th FYP [37]. The lowering of the 12th FYP target was likely the result of intense bargaining between the central government and provincial governments [66]. The second adjustment is the frequency of assessment. One of the problems with the 11th FYP responsibility system was that there was only one assessment, held at the end of 2010. This led to procrastination by some local governments in implementing energy conservation policies. To address this problem, assessment was carried out annually in the 12th FYP period.

The third modification is that the provincial energy intensity targets of the 12th FYP (Table 4) have been allocated less uniformly. In the 11th FYP period, most provinces were given a 20% target, including the most developed (Beijing and Shanghai) and the least developed (Guizhou and Gansu) provinces. In the 12th FYP period, the allocation was more stratified, with five provinces given 18%, five 18%, four 17%, twelve 16%, six 15% and three 10%. Three provinces were given the lowest target because they had difficulty meeting targets during the 11th FYP period. It is unclear how the rest of the targets were allocated, except that regional differences were taken into consideration. The top bracket consists of developed provinces, whereas the second-lowest bracket consists predominantly of underdeveloped western and central provinces. This allocation of targets represents an improvement over the 11th FYP version, which was often criticized as being too uniform.

The last fine-tuning is the introduction of sectoral energy conservation targets (Table 5). Four ministries have released, for the first time, energy conservation plans for the sectors for which they are responsible. The effect of having sectoral targets is that the ministries will bear more responsibility in energy conservation during the 12th FYP period. However, because the relationship between most central ministries and local ministries is that of guidance rather than authority [67], most sectoral targets are not mandatory. It would be sensible therefore not to overestimate their importance.

Table 5
12th FYP sectoral energy conservation targets.

Sector	Responsible agency	Key targets	Policy document
Industry	Ministry of Industry and Information Technology (MIIT)	Reduce industrial energy intensity by 21%, conserve 670 Mtce of energy	[6]
Building	Ministry of Housing and Urban–Rural Development (MOHURD)	Conserve 116 Mtce of energy	[7]
Construction	Ministry of Housing and Urban–Rural Development (MOHURD)	Reduce energy intensity of the construction process by 10%	[68]
Transport	Ministry of Transport (MOT)	Using a 2005 baseline, reduce energy intensity of commercial vehicles by 10%, reduce energy intensity of commercial boats by 15%, reduce energy intensity of harbors by 8%	[8]
Public	Government Offices Administration (GOA)	Reduce per capita energy consumption by 15% and building energy use per unit area by 12%	[9]

Note: Energy intensity of transport is defined as energy consumption relative to the amount of freight or passengers carried and the distance traveled.

Table 6
Comparison of the Ten Thousand Enterprise Program and the Thousand Enterprise Program.

	Thousand Enterprise Program (11th FYP)	Ten Thousand Enterprise Program (12th FYP)
Entry criterion	> 180,000 tce	> 10,000 tce
Number of enterprises	1008	14641
Total energy conservation target	100 Mtce	250 Mtce
Average energy conservation	10,289	17,146
Maximum energy conservation	2,000,000	2,150,000
Minimum energy conservation	2100	50

Source: [5,20,39].

Table 7
Changes to the Obsolete Capacity Retirement Program.

Industry	11th FYP target (million tons unless specified)	12th FYP target (million tons unless specified)	Change in percentage (%)
Iron	48	100	−52
Coke	42	80	−47.5
Citric acid	0.0475	0.08	−40.6
Industrial alcohol	1	1.6	−37.5
Steel	48	55	−12.7
MSG	0.182	0.2	−9
Aluminum	0.9	0.65	38.5
Cement	370	250	48
Ferroalloy	7.4	4	85
Calcium carbide	3.8	2	90
Paper	15	6.5	130
Glass	90 million cases	30 million cases	200
Copper	0.8	New	n/a
Lead	1.3	New	n/a
Zinc	0.65	New	n/a
Leather	11 million sheets	New	n/a
Printing and dyeing	5.58 billion m^2	New	n/a
Chemical fiber	0.59	New	n/a
Lead battery	7.46 million kVA h	New	n/a

Source: [18,42].

3.2. Industry

The industry sector continues to be the most important sector for energy conservation in the 12th FYP period. In fact, the 12th FYP target for industrial energy conservation is set at 670 Mtce, which is equal to the overall target [6].

In the 12th FYP period, the Ten Thousand Enterprise Energy Conservation Program ("Ten Thousand Enterprise Program") supersedes the Thousand Enterprise Program discussed in Section 2. Table 6 compares the two programs. The key change is that enterprises that consumed more than 10,000 tce of energy annually are now regulated. Consequently, the number of enterprises regulated by the program increased almost fifteen-fold. While only energy-intensive sectors were targeted in the 11th FYP period, the new program encompasses almost every type of industry, from breweries to water suppliers to drug manufacturers. It is interesting to note that although many of these newly added companies were assigned a smaller targets because of their low energy consumption, the average target increased. This is because many, but not all, of the energy-intensive companies had their targets increased from the 11th FYP period. This is not surprising considering that the majority of them had performed better than anticipated in the 11th FYP period, which the policymakers took to mean that previous targets were set too low. As an extreme example, Sinopec Beijing Yanshan Company was given a 108,600 tce target in the 11th FYP period. However, because the company successfully conserved 2,955,000 tce, it was given a target of 638,378 tce in the 12th FYP period.

The Obsolete Capacity Retirement Program has been expanded to cover nineteen industries (Table 7). Of the old industries, six have had their targets increased while six others have had their targets decreased. The reasons for these changes have not been made clear, but practicality was likely to have been one of the major considerations. Because of the many incidents of cheating in the 11th FYP period, an update was implemented in May 2011 to tighten the requirements for obtaining funding [41]. Enterprises that have not been in a normal state of production for the past three years do not qualify. Moreover, to prevent the misuse of funding by local governments, the document stipulates that funding must be earmarked for worker placement, debt repayment and other expenses related to obsolete capacity retirement.

The main incentive program of the 11th FYP period, the Energy Conservation Technology Fund, was modified in two ways to make it easier for enterprises to apply for subsidies. First, projects that conserve 5000 tce or more are eligible, which is a decrease from the previous threshold of 10,000 tce [43]. Second, the limitation on specific technologies listed in the Ten Key Projects has been removed. Third, funding has been increased from 200 to 240 RMB/tce for eastern provinces and from 250 to 300 RMB/tce for central and western provinces.

A new policy has been formulated by NDRC to develop the energy services industry. Energy services companies (ESCOs) provide comprehensive solutions for improving energy efficiency [69]. They help to overcome financial and technical constraints to energy efficiency investment. However, ESCOs are unable to realize their full potential in China because of market, institutional and financial barriers [70]. To support the energy services industry, the Ministry of Finance introduced a subsidy in 2011 for energy conservation projects run by ESCOs, at a rate of 300

RMB/tce of energy saved [49]. This is in addition to the Energy Conservation Technology Fund, which means that an enterprise can claim up to 600 RMB/tce of subsidies if it satisfies the requirements for both programs. Concessions on business tax, value-added tax and income tax are also granted to ESCOs [48].

3.3. Building

The building sector, including residential, commercial and public buildings, accounts for approximately 30% of total energy consumption in China [71]. The 12th FYP energy conservation target for the building sector is to save 116 Mtce in five years [7]. The target will be achieved through four key measures: tightening the Building Energy Efficiency Standard to 65% of the 1980s level (saving 45 Mtce), (2) retrofitting existing buildings (saving 27 Mtce), (3) retrofitting public buildings and installing energy monitoring systems (saving 14 Mtce) and (4) promoting integrated renewable power (saving 30 Mtce). The cost of retrofitting will be primarily borne by the government. While none of these policies are new, there is evidence that the government is increasing the scale of investment. During the 11th FYP period, the central government invested 4.6 billion RMB in retrofitting existing buildings. The figure has grown to 9.1 billion RMB from 2011 to 2013 [71].

In June 2009, NDRC and MOF jointly launched the Energy-Efficient Product Discount Scheme [51]. Aimed at promoting domestic consumption and energy conservation, the program initially offered generous subsidies for air conditioners and light bulbs. The program proved popular, and in 2012, subsidies were expanded to seven categories (Table 8). Additionally, two new energy conservation policies developed by NDRC will have an impact on the building sector. First, differential electricity pricing will be introduced to residential and commercial buildings. The proposal has a three-step structure. The first step will be set at the current subsidized price. The second step will be set to recover full cost. Finally, the third step will take resource scarcity and pollution externalities into account [53]. Understandably, NDRC is cautious about potential social problems caused by the electricity price hike, and advises local governments to implement the policy only when the conditions are right. The second new policy is the incandescent lighting phasing-out program, which is modeled after a similar European program [72]. The plan is to begin in October 2012 with bans on importing and selling traditional light bulbs over 100 W [52].

NDRC's Ten Thousand Enterprise Program (see Section 3.3) introduced mandatory energy savings targets to commercial and public buildings on a limited scale. The program targets 103 catering businesses (mostly hotels), 234 commercial enterprises (mostly shopping malls) and 555 schools (mostly universities). As with industrial enterprises, these commercial enterprises and schools are required to establish long-term energy management systems and meet assigned energy savings targets. In total, the regulated enterprises are expected to contribute 0.96 Mtce of energy savings [39]. Finally, the subsidy program to ESCOs (see Section 3.3) is likely to be beneficial to commercial and public buildings. From international experience, ESCOs are just as likely to work with the commercial and public sectors as with the industrial sector [69,73].

Table 8
Energy-Efficient Product Discount Scheme.

Item	Year	Subsidy (RMB/unit)	Units sold	Electricity conserved annually
Light bulbs	2008	30%–50%	360 million	12.5 billion kW h
Air-conditioners	2009	300–650	34 million	10 billion kW h
Flat-panel TVs	2012	100–400	n/a	n/a
Washing machines	2012	70–260	n/a	n/a
Water heaters	2012	100–550	n/a	n/a
Refrigerators	2012	70–400	n/a	n/a
Desktop PCs	2012	260	n/a	n/a

Source: [74–81].

3.4. Transport

While the transport sector accounted for only 8% of China's total energy consumption in 2010, the sector used 46.5% of all of the gasoline consumed in China, 91.8% of the kerosene, 58% of the diesel fuel and 35.3% of the fuel oil [37]. As oil supply security becomes an increasingly urgent issue [82,83], the stakes for conserving energy in the transport sector also become higher.

Compared to other sectors, the transport sector is a latecomer to energy conservation. It was not until 2010 that the Ministry of Transport (MOT) introduced a number of policies aimed at improving energy efficiency in the sector. Starting in March 2010, MOT did not issue road transport permits to commercial vehicles that did not satisfy fuel efficiency standards. The Road Passenger Transport Capacity Control Program, also introduced in 2010, is a transport sector version of the Obsolete Capacity Retirement Program. The aim of the program is to reduce the capacity of road passenger transport services that operate at less than 70% of capacity [57]. Services targeted for elimination will not have their road transport permits renewed. In April 2010, MOT released its own version of the Thousand Enterprise Program, although participation was voluntary. By August 2010, 1126 enterprises had signed up and set their own energy savings targets [84]. In June 2011, the transport energy conservation fund was created to support transport enterprises in energy conservation [58]. The central government has invested 250 million RMB in 122 programs, which are estimated to have conserved 0.315 Mtce of energy [85]. MOT has also funded a series of

Table 9
Public Sector Key Energy Conservation Projects.

Project description	Energy conservation target (Mtce)
Renovate 2000 government buildings, schools and hospitals	1.2
Install 25 million energy-efficient light bulbs	0.6
Install passive cooling and optimize layout of 1000 public data centers	0.4
Install 12 million energy-saving sockets	0.64
Install energy-efficient stoves in public institution canteens	0.36
Renovate 30 million square meters of government buildings	1.3
Install 1000 solar water heaters, 100 solar heaters, 1000 solar photovoltaic projects, and 1000 geothermal heat pumps	0.2
Gradually increase the proportion of new energy vehicles to 50% of all new purchases by 2015	n/a

Source: [9].

demonstration and R&D programs such as the low-carbon transport system development program [85].

NDRC's Energy-Efficient Product Discount Scheme and Ten Thousand Enterprise Program are also relevant to the transport sector. Starting in 2010, purchases of energy-efficient automobiles were subsidized by 3000 RMB through the Energy-Efficient Product Discount Scheme [86]. The scheme was very popular, and by the end of 2010, more than 1 million energy-efficient automobiles were sold [81]. The Ten Thousand Enterprise Program introduced mandatory energy conservation to the transport sector on a limited scale. Transport enterprises that consumed over 10,000 tce of energy, owned more than 600 vehicles or operated harbors with over 50 million tons of cargo throughput in 2010 are included. In total, 546 transport enterprises are regulated, and their collective target amounts to 3.1 Mtce [39].

3.5. Public sector

The public sector has been a keen participant in energy conservation around the world [87,88] and the public sector in China is no exception. The public sector in China contributed to 33.91 Mtce of energy savings from 2006 to 2010 [9]. The importance of the public sector in energy conservation is underlined by the fact that, compared to the rest of the world, China has a very large public sector. There are 1.9 million government agencies, including ministries, schools, hospitals, R&D institutions, cultural institutions, sport institutions and social organizations, consuming a total of 6.19% of China's energy [9].

In addition to the public building programs discussed in Section 3.4, there are three other programs developed by the Government Offices Administration (GOA) and other agencies to improve energy efficiency in the public sector: the Public Sector Key Energy Conservation Projects (Table 9), compulsory government procurement of energy-saving products and the City Green Lighting Project. All of them are a continuation of previous policies, and no new policies have been introduced since 2011. The green street lighting program lowers the energy efficiency target to 15%, a decrease from 25% in the 11th FYP period [61]. This decrease is probably due to the result of the failure to achieve the 11th FYP target.

4. Conclusions

Our analysis shows that the majority of energy conservation policies and programs in the 12th FYP period are carried over from the 11th FYP period. Novelty centers around new policy instruments (e.g., promoting ESCOs) and the involvement of new sectors (e.g., transport and commercial buildings). Changes are introduced based on small steps and trial and error, whereas key elements of the 11th FYP remain. The focus continues to be on improving energy efficiency in the industry sector. Regulations continue to be the policy instrument of choice, despite the aspiration to use more economic instruments. To return to our opening question, calling energy conservation in the 12 FYP period a new paradigm would be an overstatement. This is not to say that changes in the 12th FYP period are unimportant. On the contrary, we believe that the modifications to the allocation of targets, the frequency of assessment and the eligibility of subsidies and incentives are all examples of rational fine-tuning that contribute to the efficiency of the program. Moreover, the expansion of both the regulatory net and government investment demonstrates that energy conservation is still one of the most important policy issues in the 12th FYP period.

Nevertheless, we question whether the changes are sufficient to achieve the new energy conservation goals. One problem is the reliance on regulation. While the method was largely successful in the 11th FYP period, it was helped by the fact that only a small number of enterprises were regulated, which reduced the cost of direct monitoring [12]. As the number of actors increases substantially in the 12th FYP, it is unclear whether the administrative approach will remain effective. More significantly, as explained in Section 2.4, a key predicament in the 11th FYP period was the failure to bring about structural change of the economy. However, no new policies have been introduced to address this deficiency. In 2011, the first year of the 12th FYP period, the economy grew by 9.2%, the industry sector by 10.7% and the heavy industry sector by 14.3% [89]. These figures show that the institutional problems that cause local governments to develop heavy industry have not been addressed, and the key question of how to change the path of development to bring on structural adjustment remains unanswered [2].

To end on a positive note, the introduction of an energy consumption cap could be a solution to the structural change problem. The State Council has declared that it would introduce an energy consumption cap in the 12th FYP period as a political target, in the same way as energy intensity targets were introduced [3]. The national target has not been finalized, but it is likely to be set in the range of 4000–4200 Mtce of annual energy consumption in 2015. Considering that 3480 Mtce of energy was consumed in 2011 [89], the national cap will be restrictive and will force local governments to diversify the economy away from energy-intensive industries. The drafting process of the policy has been stalled by disagreement over the allocation of provincial-level caps and resistance from local governments that are concerned about economic development [90]. Despite these difficulties, solid steps are being taken to introduce the energy consumption cap during the 12th FYP period.

Acknowledgments

We thank Prof. Tong Lianjun and Dr. Li He from the Northeast Institute of Geography and Agroecology for their help with the project. We also thank Emily Sim for the editing of the paper. This project received financial support from the Australian Research Council Grant (DP1094801) [Low-carbon Project] and School of Land and Environment, University of Melbourne.

References

[1] Yuan X, Zuo J. Transition to low carbon energy policies in China—from the Five-Year Plan perspective. Energy Policy 2011;39:3855–9.
[2] Li J, Wang X. Energy and climate policy in China's Twelfth Five-Year Plan: a paradigm shift. Energy Policy 2012;41:519–28.
[3] State Council. 12th FYP energy conservation and emission reduction work plan; 2011. 〈http://www.gov.cn/zwgk/2011-09/07/content_1941731.htm〉.
[4] Council S. 12th FYP for energy conservation and emission reduction; 2012. 〈http://www.gov.cn/zwgk/2012-08/21/content_2207867.htm〉.
[5] National Development and Reform Commission (NDRC). Implementation Plan for the Ten-Thousand Enterprise Energy Conservation Program; 2011. 〈http://www.ndrc.gov.cn/zcfb/zcfbtz/2011tz/t20111229_453569.htm〉.
[6] Ministry of Industry and Information Technology (MIIT). 12th FYP for industry energy conservation; 2012. 〈http://www.miit.gov.cn/n11293472/n11293832/n11293907/n11368223/14475991.html〉.
[7] Ministry of Housing and Urban–Rural Development (MOHURD). 12th FYP for building energy conservation; 2012. 〈http://www.gov.cn/zwgk/2012-05/31/content_2149889.htm〉.
[8] Ministry of Transport (MOT). 12th FYP for transport energy conservation; 2011. 〈http://www.gov.cn/gongbao/content/2012/content_2076113.htm〉.
[9] Government Offices Administration (GOA). 12th FYP for government agency energy conservation; 2011. 〈http://www.ggj.gov.cn/gwfb/201110/t20111010_275650.htm〉.
[10] Zhou N, Levine MD, Price L. Overview of current energy-efficiency policies in China. Energy Policy 2010;38:6439–52.
[11] Price L, Levine MD, Zhou N, Fridley D, Aden N, Lu H, et al. Assessment of China's energy-saving and emission-reduction accomplishments and opportunities during the 11th Five-Year Plan. Energy Policy 2011;39:2165–78.

[12] Yuan J, Kang J, Yu C, Hu Z. Energy conservation and emissions reduction in China—progress and prospective. Renewable and Sustainable Energy Reviews 2011;15:4334–47.
[13] Andrews-Speed P. China's ongoing energy efficiency drive: origins, progress and prospects. Energy Policy 2009;37:1331–44.
[14] Zhang D, Aunan K, Seip HM, Vennemo H. The energy intensity target in China's 11th Five-Year Plan period—local implementation and acheivements in Shanxi Province. Energy Policy 2011;39:4115–24.
[15] Eichhorst U, Bongardt D. Towards cooperative policy approaches in China—drivers for voluntary agreements on industrial energy efficiency in Nanjing. Energy Policy 2009;37:1855–65.
[16] Hu Y. Implementation of voluntary agreements for energy efficiency in China. Energy Policy 2007;35:5541–8.
[17] Wang R, Liu W, Xiao L, Liu J, Kao W. Path towards achieving of China's 2020 carbon emission reduction target—a discussion of low-carbon energy policies at province level. Energy Policy 2011;39:2740–7.
[18] State Council. 11th FYP energy conservation and emission reduction work plan; 2006. 〈http://www.gov.cn/jrzg/2007-06/03/content_634545.htm〉.
[19] National development and Reform Commission (NDRC). 11th Five-Year period energy conservation review (1): Energy conservation achieved significant results; 2011. 〈http://www.ndrc.gov.cn/xwfb/t20110310_399044.htm〉.
[20] National Development and Reform Commission (NDRC). Implementation plan for the Thousand Enterprise Energy Conservation Program; 2006. 〈http://hzs.ndrc.gov.cn/newzwxx/t20060413_66111.htm〉.
[21] National Development and Reform Commission (NDRC). Implementation plan for the Ten Key Energy Conservation Projects; 2006. 〈http://www.ndrc.gov.cn/zcfb/zcfbtz/tz2006/t20060802_78934.htm〉.
[22] State Council. Interim provisions to faciliate the adjustment of industrial structure; 2005. 〈http://www.ndrc.gov.cn/zcfb/zcfbqt/zcfb2005/t20051222_54302.htm〉.
[23] National Development and Reform Commission (NDRC). 11th FYP energy conservation and emission reduction review (3): Ten Key Energy Conservation Projects have achieved significant results; 2011. 〈http://www.gov.cn/gzdt/2011-09/29/content_1959553.htm〉.
[24] National Development and Reform Commission (NDRC). Result of the Thousand Enterprise Energy Conservation program; 2011. 〈http://www.sdpc.gov.cn/zcfb/zcfbgg/2011gg/t20111227_452721.htm〉.
[25] Price L, Wang X, Yun J. The challenge of reducing energy consumption of the Top-1000 largest industrial enterprises in China. Energy Policy 2010;38:6485–98.
[26] Zhao X, Ortolano L. Implementing China's national energy conservation policies at state-owned electric power generation plants. Energy Policy 2010;38:6293–306.
[27] National Development and Resource Comission (NDRC). 11th FYP energy conservation review 3—retirement of backward capacities achieved significant results; 2011. 〈http://www.gov.cn/gzdt/2011-03/10/content_1821724.htm〉.
[28] Liu Y. No stopping of electricity restriction China. Construction News 2010.
[29] Xiang Z Electricity restriction unstoppable. Xinhua; 2010.
[30] Levine MD, Price L, Zhou N, Fridley D, Aden N, Lu H, et al. Assessment of China's energy-saving and emission-reduction accomplishments and opportunities during the 11th Five-Year Plan. Ernest Orlando Lawrence Berkeley National Laboratory; 2010.
[31] Fisher-Vanden K, Jefferson GH, Liu H, Tao Q. What is driving China's decline in energy intensity? Resource and Energy Economics 2004;26:77–97.
[32] Chai J, Guo J-E, Wang S-Y, Lai KK. Why does energy intensity fluctuate in China? Energy Policy 2009;37:5717–31.
[33] Wu L, Kaneko S, Matsuoka S. Driving forces behind the stagnancy of China's energy-related CO_2 emissions from 1996 to 1999: the relative importance of structural change, intensity change and scale change. Energy Policy 2005;33:319–35.
[34] Zhao X, Ma C, Hong D. Why did China's energy intensity increase during 1998–2006: decomposition and policy analysis. Energy Policy 2010;38:1379–88.
[35] van den Bergh JCJM. Energy conservation more effective with rebound policy. Environmental & Resource Economics 2011;48:43–58.
[36] National Bureau of Statistics (NBS). China statistical yearbook 2011; 2011.
[37] National Bureau of Statistics (NBS). China energy statistical yearbook 2011; 2011.
[38] State Council. Implementation plan for energy conservation accounting, monitoring and evaluation; 2007. 〈http://www.gov.cn/zwgk/2007-11/23/content_813617.htm〉.
[39] National Development and Reform Commission (NDRC). Ten-Thousand Energy Conservation Program: Participating enterprises and their targets; 2012. 〈http://www.gov.cn/zwgk/2012-05/21/content_2142033.htm〉.
[40] State Council. Notice to strengthen the implementation of the Obsolete Capacity Retirement Program; 2010. 〈http://www.gov.cn/zwgk/2010-04/06/content_1573880.htm〉.
[41] Ministry of Finance (MOF). Management of the obsolete capacity retirement fund; 2011. 〈http://jjs.mof.gov.cn/zhengwuxinxi/zhengcefagui/201105/t20110505_545241.html〉.
[42] Ministry of Industry and Information Technology (MIIT). 12th FYP targets for the Obsolete Capacity Retirement Program; 2011. 〈http://www.miit.gov.cn/n11293472/n11295023/n11297848/14410223.html〉.
[43] Ministry of Finance (MOF). Administration of the energy conservation technology fund; 2011. 〈http://www.ndrc.gov.cn/zcfb/zcfbqt/2011qt/t20110701_421413.htm〉.
[44] National Development and Reform Commission (NDRC). Opinions on improving the differential electricity pricing policy; 2006. 〈http://www.gov.cn/zwgk/2006-09/22/content_396258.htm〉.
[45] Ministry of Finance (MOF), Ministry of Industry and Information Technology (MIIT). Management of the small business closure assistance fund; 2010. 〈http://www.gov.cn/gongbao/content/2011/content_1786417.htm〉.
[46] Ministry of Finance (MOF), National Development and Reform Commission (NDRC). Interim management measures for the energy efficient products promotion fund; 2009. 〈http://www.mof.gov.cn/pub/gp/jingjijianshesi/200905/t20090521_159526.html〉.
[47] National Development and Reform Commission (NDRC). Implementation plan for the 12th FYP National Energy Conservation Campaign; 2012. 〈http://www.gov.cn/zwgk/2012-02/07/content_2059923.htm〉.
[48] State Council. Opinions on accelerating the development of the energy services industry; 2010. 〈http://www.gov.cn/zwgk/2010-04/06/content_1573706.htm〉.
[49] Ministry of Finance (MOF), National Development and Reform Commission (NDRC). Interim measures for the management of contract energy management fund; 2011. 〈http://www.ndrc.gov.cn/zcfb/zcfbqt/2010qt/t20100609_353606.htm〉.
[50] National Development and Reform Commission (NDRC). Notice on the recommendation of national key energy conservation technologies; 2012. 〈http://www.ndrc.gov.cn/zcfb/zcfbtz/2012tz/t20120217_462028.htm〉.
[51] Ministry of Finance (MOF), National Development and Reform Commission (NDRC). Notice regarding the Energy Efficient Product Discount Scheme; 2009. 〈http://www.sdpc.gov.cn/zcfb/zcfbqt/2009qt/t20090525_281605.htm〉.
[52] National Development and Reform Commission (NDRC). Roadmap on phasing out incandescent lighting; 2011. 〈http://www.sdpc.gov.cn/zcfb/zcfbgg/2011gg/t20111114_444229.htm〉.
[53] National Development and Reform Commission (NDRC). Guidance on residential electricity ladder tariff (pilot); 2011. 〈http://www.ndrc.gov.cn/zcfb/zcfbtz/2011tz/t20111130_448384.htm〉.
[54] Ministry of Transport (MOT). Administration methods for vehicle fuel consumption testing and supervision; 2009. 〈http://atestsc.mot.gov.cn/pub/_content/10_02/09/1265692764402.html〉.
[55] Ministry of Transport (MOT). Commercial (passenger) vehicle fuel standards and measurement methods; 2008. 〈http://www.zsda.gov.cn/uploads/soft/091203/4-091203095120.pdf〉.
[56] Ministry of Transport (MOT). Commercial (goods) vehicle fuel standards and measurement methods; 2008. 〈http://www.stxygs.cn/E_ReadNews.asp?NewsID=677〉.
[57] Ministry of Transport (MOT). Notice on strengthening the control of road passenger transport capacity; 2010. 〈http://www.wwwauto.com.cn/HYfgzc/kYkZ/JYF-2010-390.htm〉.
[58] Ministry of Finance (MOF), Ministry of Transport (MOT). Interim measures for the management of the transport energy conservation fund; 2011. 〈http://www.moc.gov.cn/zhuzhan/zhengwugonggao/jiaotongbu/qita/201107/t20110705_977690.html〉.
[59] Ministry of Transport (MOT). Notice of recommending transport energy conservation demonstration projects (fifth batch); 2012. 〈http://www.moc.gov.cn/zhuzhan/zhengwugonggao/jiaotongbu/qita/201201/t20120120_1187415.html〉.
[60] Ministry of Transport (MOT). Initiation of low carbon transport system pilot cities (second batch); 2012. 〈http://www.gov.cn/gzdt/2012-02/13/content_2064912.htm〉.
[61] Ministry of Housing and Urban–Rural Development (MOHURD). 12th FYP for green city lighting; 2011. 〈http://www.gov.cn/gzdt/2011-11/15/content_1993931.htm〉.
[62] State Council. Notice on complusory procurement of energy conservation products; 2007. 〈http://www.gov.cn/zwgk/2007-08/06/content_707549.htm〉.
[63] Edin M. Remaking the communist part-state: the cadre responsibility system at the local level in China. China: An International Journal 2003;1:1–15.
[64] Göbel C. Uneven policy implementation in rural China. The China Journal 2011;65:53–76.
[65] O'Brien K, Li L. Selective policy implementation in rural China. Comparative Politics 1999;31:167–86.
[66] Feng J. 12th Five-Year Plan energy conservation policy decision: the gaming of localities. Nanfang Dushibao 2011 3-11-2011.
[67] Zhou Z. Research on the relationship between the government functional departments and local government in contemporary China. Tianjin: Tianjin People's Publishing House; 2009.
[68] Ministry of Housing and Urban–Rural Development (MOHURD). 12th FYP for the construction sector; 2011. 〈http://www.gov.cn/zwgk/2011-08/18/content_1927995.htm〉.
[69] Marino A, Bertoldi P, Rezessy S, Boza-Kiss B. A snapshot of the European energy service market in 2010 and policy recommendations to foster a further market development. Energy Policy 2011;39:6190–8.
[70] Gan D. Energy service companies to improve energy efficiency in China: barriers and removal measures. Procedia Earth and Planetary Science 2009;1:1695–704.
[71] Ministry of Housing and Urban–Rural Development (MOHURD). Zhang Shaochun: further promoting existing residential buildings energy conservation; 2011. 〈http://jjs.mof.gov.cn/zhengwuxinxi/lingdaojianghua/201107/t20110714_576304.html〉.

[72] Frondel M, Lohmann S. The European Commission's light bulb decree: another costly regulation? Energy Policy 2011;39:3177–81.
[73] Vine E. An international survey of the energy service company (ESCO) industry. Energy Policy 2005;33:691–704.
[74] National Development and Reform Commission (NDRC). Interim measures for subsidizing energy efficient lighting products; 2007. 〈http://www.sdpc.gov.cn/hjbh/hjjsjyxsh/t20080508_210085.htm〉.
[75] Ministry of Finance (MOF), National Development and Reform Commission (NDRC), Ministry of Industry and Information (MITT). Energy Efficient Product Discount Scheme energy efficient air conditioners implementation details; 2009. 〈http://www.gov.cn/gzdt/2009-05/20/content_1320247.htm〉.
[76] Ministry of Finance (MOF), National Development and Reform Commission (NDRC), Ministry of Industry and Information (MITT). Energy Efficient Product Discount Scheme energy efficient flat-panel TV implementation details; 2012. 〈http://www.gov.cn/zwgk/2012-05/28/content_2147041.htm〉.
[77] Ministry of Finance (MOF), National Development and Reform Commission (NDRC), Ministry of Industry and Information (MITT). Energy Efficient Product Discount Scheme energy efficient washing machines implementation details; 2012. 〈http://www.miit.gov.cn/n11293472/n11293832/n12843926/n13917057/14647399.html〉.
[78] Ministry of Finance (MOF), National Development and Reform Commission (NDRC), Ministry of Industry and Information (MITT). Energy Efficient Product Discount Scheme energy efficient water heaters implementation details; 2012. 〈http://jjs.mof.gov.cn/zhengwuxinxi/zhengcefagui/201206/t20120604_656864.html〉.
[79] Ministry of Finance (MOF), National Development and Reform Commission (NDRC), Ministry of Industry and Information (MITT). Energy Efficient Product Discount Scheme energy efficieny refrigerator implementation details; 2012. 〈http://www.sdpc.gov.cn/zcfb/zcfbqt/2012qt/t20120608_484887.htm〉.
[80] Ministry of Finance (MOF), National Development and Reform Commission (NDRC), Ministry of Industry and Information (MITT). Energy Efficient Product Discount Scheme energy efficient desktop PCs implementation details; 2012. 〈http://www.gov.cn/zwgk/2012-09/24/content_2231950.htm〉.
[81] National Development and Reform Commission (NDRC). 11th FYP energy conservation and emission reduction review (6): Energy Efficient Product Discount Scheme has obtained outstanding results; 2011. 〈http://www.ndrc.gov.cn/xwfb/t20111009_437354.htm〉.
[82] Downs E. The Chinese energy security debate. China Quarterly 2004;177:2–41.
[83] Moore S. Strategic imperative? Reading China's climate policy in terms of core interests Global Change, Peace and Security 2011;23:147–57.
[84] Ministry of Transport (MOT). Thousand Enterprise Low Carbon Program (transport) company list. 2010.
[85] Ministry of Transport (MOT). Progress report for 2011 transport sector energy conservation; 2012. 〈http://jtjnw.mot.gov.cn/wenjiangg/201202/t20120209_1192453.html〉.
[86] Ministry of Finance (MOF), National Development and Reform Commission (NDRC), Ministry of Industry and Information (MITT). Energy Efficiency Product Discount Scheme energy efficient automobile promotion implementation details; 2010. 〈http://www.sdpc.gov.cn/zcfb/zcfbqt/2010qt/t20100603_351138.htm〉.
[87] Bulkeley H, Kern K. Local government and the governing of climate change in Germany and the UK. Urban Studies 2006;43:2237–59.
[88] Bulkeley H, Betsill MM. Cities and climate change: urban sustainability and global governmental governance. Oxon: Routledge; 2003.
[89] National Bureau of Statistics. 2011 China national economic and social development statistics bulletin; 2012. 〈http://www.stats.gov.cn/tjgb/ndtjgb/qgndtjgb/t20120222_402786440.htm〉.
[90] Feng J. The stalling of energy consumption cap? The intensification of bargaining between central and local governments Nanfang Zhoumo 2012 〈http://www.infzm.com/content/74376〉.